Observations on the Habits of Some Pond Life from the West Indies.

By Henry W. King.

Plates VIII. and IX.

(*Read September 16th*, 1892.)

Some months ago I suggested to a friend travelling to the West Indies the possibility of bringing pond life from there to this country alive for observation. Knowing the extremes of heat and cold and altered conditions in which lower life in general can live, it seemed quite feasible, and my friend, a Mr. Inglis, kindly offered to bring some with him on his return journey.

I received from him two jars containing dippings from Port Limon and the Island of Colon.

Flag plants grew there, and shrubs and trees flourished by the water's side, providing shade and shelter to alligators bathing in the waters. Naturally favourable spots for microscopic life, it was not surprising some interesting forms should be found living and preying either upon the vegetable or the excrement and remains of animal life abounding there.

The waters were clear, with sedimentary matter at the bottom, that from Port Limon having by far the most, and was of a darker colour than that brought from Colon. All the water plants in both dippings were dead and discoloured, through decay, but the forms of some were partially retained, and the remains of grass stems and roots could be distinguished in the former dipping, while in the latter I have no doubt there were the remains of plants of a species of Chara or Nitella.

A glance with a lens at the waters at once revealed their animated condition. A Cypris would glide with alternate opening and closing valves over the sedimentary refuse, and small worms and Rotifers were swimming freely through the water and among the remains of vegetation from Colon, while

Cyclops swam with its well-known series of jerks, and larvæ of a species of Tipula wriggled their way in the water brought from Port Limon.

Thus both waters appeared to have a fully-inhabited look about them. The many weeks' oscillation on the sea, the changes of temperature, the altered influences of conditions generally, seeming to produce but little harm upon the life in the waters, other than upon the higher life of the water plants, which were unable to adapt themselves to the changes, and perished, though the spores of Algæ have retained their vitality, and are now germinating among the vegetal decay and extending their long green cells.

One of the most numerous forms of life in the water from Colon is a worm of the curious form figured (Pl. IX., Fig. 1). It lives about the stems, rootlets, and refuse in the water, among which it glides, the hair-like tufts from each annulose aiding it in its motion by fixing on the materials on which it is moving, and the muscular bands proceeding in a zigzag line along each side of the animal, by contracting, causes a serpentine movement of the body. Situated at the back of the head are two tufts of hairs which have a very different function to the hairs running along each side of the animal. They do not take part in progression, but, with a strong, nervous impulse, are in a perpetual tremulous vibration when erect, like the antennæ of many insects, notably the Ichneumons. They are longer than the other hairs on the body, and are capable of being folded down, either over the back or forward over the head, according to the direction in which the creature is moving.

The head is tapering, and ends in a long trunk of a very flexible and sensitive nature, capable of being curved or coiled in any direction. The animal uses it mainly for thrusting round stems to aid in drawing itself along, or when the creature is in a vegetable tube, to assist it in making a way, clearing obstructions, and generally feeling its course, and is useful also to assist it up a tube by casting the trunk over the aperture, and assisting in drawing itself out.

It is curious to observe these creatures making their way along a vegetable tube, feeding now, and then gliding a little way, resting a time, then gliding to fresh provender a little further off, in a most happy and contented mood, and living in

this manner sometimes a couple of days in one tube. Sometimes they partially protrude from the tube, thrusting the proboscis in all directions, as if to find the whereabouts of other stems, and then, as if fearful of danger, darting back in the tube as a Mellicerta will do, as though quite conscious of the protective nature of the acquired tube. In doing so, the head is often drawn in so as to throw a fold of the integument partially over it. When feeding upon the vegetable or animal matter softened by maceration in the water, the trunk is mostly curved back over its head, that the mouth, situated upon the under side of the head, near the base of the trunk of the animal, may the better reach the food (Fig. 2, Pl. IX.).

The aperture of the mouth is opened like lips, and the œsophageal bulb (Fig. 2, *a*, Pl. IX.) is thrust forward beyond the lip-like opening, and by a series of quick thrusting out and retractile motions of the œsophagus, the food is torn from what it is adhering to, and quickly passes into the stomach by the relaxation of sphincter muscles at the larger end. After remaining there but a very short time, the food is released by other sphincter muscles at the base of the stomach, and it passes into the intestine, through which it is quickly carried by the peristaltic action of the muscles composing its walls. When the animal is actively engaged in feeding, the remains of the food are expelled in about seven minutes from the time it enters the gullet, to be preyed upon by small Rotifers, Diatoms, and Monads.

These worms, wallowing in numbers among decaying and decayed matter, and nearly always feeding, must have a powerful influence in keeping water pure in a tropical climate, by quickly devouring the refuse falling in the water from animals, insects, and vegetation, seeming, by the quick and almost perpetual action of their digestive system, to change and so prepare the refuse in the water that it may become adapted as food for lower life living there.

Associated with these worms, living among them, and sometimes utilizing vegetable tubes adapted by the worms, is a curious active little Rotifer, very numerous in the dipping from Colon.

This Rotifer, which I propose naming *Fercularia tubiformis*, has a broader head than the trunk, tapering slightly to the

back, with two short horn-like processes at each side, capable of slight contraction and extension. It has one ruby-coloured eye, situated upon a styliform process of the head. The outlines of the trunk follow nearly horizontally from the head to about three-fourths of the length of the animal, where the body is suddenly reduced in size, as each successive ring of the integument becomes smaller than the preceding, this annulous formation enabling the animal to curve and bend in any direction, as each larger ring of its structure works over the smaller. The tail bifurcates from the end of the body, is telescopic, and ends in two powerfully-formed, articulated, toothed claws, curved in outline, and very useful to the animal's mode of life. The animal can at will close the two bifurcating branches of the tail, with the claws attached, so that they lay in the same line but with a downward curve, as in Fig. 2, Pl. VIII. Or it may spread them rigid, as in Fig. 1, Pl. VIII., with the clawlets of the claws elevated or depressed, according to the requirements of the animal. This control over the clawlets is a very important one to this Rotifer, enabling it to use each claw of the tail as a simple tool by thrusting it into substances without the clawlets forming an obstruction, which they would do if they were fixed and always erect. Again, they are useful as a compound tool when they are elevated, by forming a notched hook, stronger and better adapted for loosening materials, and also, as in Fig. 5, Pl. VIII., for drawing earthy particles to their tubular dwellings, which they could not so well do if each claw was a plain, smooth hook.

They live almost entirely in either appropriated tubes formed by the hollow stems of aquatic plants, or burrowings of the worms aforesaid, or tubes constructed by themselves from the flocculent sediment at the bottom of the water. When forming a tube, it is interesting to notice how the animal forces its head into the decaying vegetable matter or refuse, and having made a hollow about half the length of the creature, and as if the matter would not yield further by this mode, it turns round, with its tail in the burrow and the head outside. Then, fixing its notched tail, over which it has considerable control, in either side of the burrow, it moves backwards and forwards, loosening the materials as it does so, and gradually forcing its way in, at the same time pressing the sides outwards sufficiently to enable

it to move up and down, sometimes incessantly drawing earthy particles by means of its tail, to fill up vacancies should they occur, or add to its dimensions when required.

The tubes thus formed are sometimes only three or four times, at others eighteen to twenty times its own length, or even longer. They are composed of fine earthy particles adhering without regularity to one another, often with diatoms and flocculent matter entangled among the particles, and probably held together by some viscid secretion of the animal, insoluble in water. Their forms are varied, often quite straight, at other times curved, some are turned at sharp angles, or carried crossways through other tubes not inhabited.

In all cases the tubes are constructed to enable the industrious creature to swim easily up and down them. Of this they are very particular, any obstruction by bulging out or pressing in occurring by other life coming in contact to damage the tube is at once made right by the Rotifer fixing its claw-like tail or foot to both sides of the tube and jerking backwards and forwards, by so doing again forcing the walls of the tube outwards or inwards, as the case may require, to their former position. Should some of the small earthy particles have been moved away, the Rotifer will then thrust itself out of its tubular dwelling backwards, with its head inside (and, I believe, fixed with its small horn-like processes), and then draw the particles back again in position by means of its claws.

It is a remarkable power these minute animals have over this forked tail of feeling for and selecting particles suitable to their purpose when the so-called eye-spot is hid and buried in the tube, and therefore rendered useless in this condition for action outside the tube.

When the tube appears completed and some loose material has been drawn to the openings to close them, the Rotifer may be seen to swim backwards and forwards, coursing regularly along, mostly going the entire length of the tube, though sometimes stopping short as if to feed, then turning, will go back again.

The sense of adaptability in these Rotifers must be largely developed, as they sometimes take possession of vegetable tubes, and adapt them to their requirements by building a wall with small particles of refuse across the tube (see *c*, *c*, Fig. 5, Pl.

VIII.), as if to reduce the size, and so save themselves the labour of constructing an entire tube.

On one occasion I observed another of the same species enter and pass partially down the tube while the owner was at the other end. When they met both became excited, darting backwards and forwards at one another with a rapid motion; but the trespasser soon turned and quickly fled from the tube and swam away, the pursuer stopping at the end of its tube, and, after protruding its head a little way, turned, and drawing some fine particles of earthy matter with its claws to its dwelling, it closed the aperture again, and commenced journeying up and down the tube as before.

I have watched one live in a single tube for several days, coursing incessantly up and down it, never seeming to rest either at night or day. As they only leave their tubes that they may go elsewhere to adapt or construct another, they are very rarely seen swimming free in the water. When they do they are extremely restless, and always eager to seek the refuge of a cluster of earthy particles or rootlets, into which they try to burrow. What the cause may be that induces them to leave one tube, that has cost them so much labour to make, or adapt to their requirements, for another tube, I am unable to say, unless it may be the necessity of obtaining food, as they seem to feed upon something inside their dwelling, so that when this is devoured hunger necessitates them seeking another tube for the twofold purpose of protection and a feeding ground; or it may be that ova are deposited, and when that is the case the parent leaves the tube it was in, for the use and protection of its coming offspring.

On one occasion I tried the experiment of placing one on a glass slide and allowing the water to evaporate, and after throwing itself into various positions, as if trying to find a means of making itself as small as possible, the Rotifer finally rolled itself into a spherical mass, with its extremities coiled round it, in which condition the carapace-like nature of the dorsal part of the animal may be distinctly seen. Having kept it thus dried up, wrinkled, and apparently dead for over an hour, I covered it again with some water, and in about two hours it gradually began to revive, and ultimately assume its normal condition.

By these Rotifers having the capacity of retaining their vitality after being dried up, the species is adapted for a very wide distribution, for should the ponds in which they live become dry, as frequently happens, the wind would waft these dormant spheres of life, like dust, from one locality to another, and when falling on suitable spots, and conditions being favourable, would become reanimated and originate fresh centres of development.

Another allied species was numerous in the water from Port Limon, but differing from the one just considered by having an orange-coloured body; this, however, may be mainly due to the different kind of food and the water in which it lives, as caterpillars and other life are frequently modified in colour by their diet. Whether from a different habit or owing to their large numbers, they appeared to be more associated in a colony, I had as many as five under the microscope at a time, and the tubes seemed to be more anastomosed together and crossing one another in various directions, forming a small matted mass. From the thicker, more opaque nature of their tubes it was not so easy to observe their habits as in the case of the preceding kind. This difference in their dwelling was probably due more to the different materials used giving them an altered aspect than from any variation of instinct action in their individual construction.

Both this variety and the former were very unaffected at sudden sounds and shaking, a different characteristic to that of most free swimming Rotifers, no doubt due to a sense of security felt in their closed dwelling.

A Rotifer (Fig. 6, Pl. VIII.) living in and also utilizing earthy matter for a protective purpose was at home in the water from Colon. This animal usually imbeds itself in the earthy matter in the water aggregated either among weeds or at the bottom. The lower portion of the body imbedded is curved, as it has so small a foot that it would be useless in retaining it in safety in so light and flocculent material were it not for this modified shape of its body forming, as it does, a larger surface for resistance. When disturbed it draws itself in below the surface, and the opening through which it passes in and out closes over it, so that it becomes buried until it feels the threatened danger has gone, when it may be seen to slowly un-

earth itself by pushing forward its very long horn and tapering head (Fig. 9, Pl. VIII.), with two ruby-coloured eyes, and cautiously expanding its cilia to vibrate like revolving wheels.

This Rotifer, unlike the last-described, but like most of the larger wheel-bearing kinds, is very sensitive to vibration and sound. It sometimes assumes a quiescent form when away from earthy protection, among the stems of water plants, and will remain a considerable time in this condition, apparently resting (Fig. 8, Pl. VIII.); at another time it bends its body over, reclining in a grotesque manner (Fig. 7, Pl. VIII.). May not this habit be a protective one, a simulating a worm, a growing alga, or some other form of life different to its own, so that other life preying upon it in its normal condition would not be so liable to recognize it in its assumed form ?

While these brief and fragmentary notes of the habits of the few forms of life living and carried in the small vessels of water given to me from the West Indies illustrate the ever-acting law of adaptability of life—and more in the case of the tube-dwelling Rotifers where they develop the simple action of adaptability to a higher function, that of construction, and where they not only adapt, but from materials build repetitions of the tubes that form their habitations—there are other forms in the water of Rotifers, Vorticellæ, and a variety of life interesting alike from their forms and habits, which time has not enabled me to study.

Explanation of Plate VIII.

Fig. 1.—*Fercularia tubiformis*, n.s., extended. *a*. Ruby-coloured eye supported on elevation. *bb*. Expanding and contractile prominences. *c*. Curved claws, with articulated clawlets. *d*, *e*. Caudal muscles largely developed in this species. *f*. Stomach. *g*. Rectum. *j*. Anus. *h*. Pharynx. *i*. Pharyngeal muscles.

Fig. 2.—*Fercularia tubiformis*, side view partially contracted. *a*. Eye. *b*. Expanding prominences. *c*. Claws. *d*. Clawlets. *e*. Stomach. *f*. Rectum, both containing diatoms, *gg*.

Fig. 3.—Enlarged ventral view of claw. *a*. Showing arrangement of clawlets, *bb*.

Fig. 4.—*Fercularia tubiformis* dried, showing carapace like nature of dorsal integument.

Fig. 5.—A colony of tubular dwellings of *F. tubiformis*, showing constructed tubes and an adapted vegetable tube. *a*. Extremity of Rotifer extended from tube-collecting refuse to close aperture of tube. *b*. Vegetable tube with Rotifer swimming inside, and (*cc*) wall of earthy particles arranged to reduce size of tube. *d*. Accumulation of refuse closing aperture of tube.

Fig. 6.—Rotifer embedded in sedimentary refuse.

Figs. 7 and 8.—Quiescent forms assumed by above.

Fig. 9.—Head of same as when first extending.

Explanation of Plate IX.

Fig. 1.—Magnified dorsal view of worm from Colon, West Indies. *a*. Tapering head. *b*. Flexible proboscis. *c*. Vibrating hairs. *d*. Anus. *e*. Largely-developed stomach. *f*. Showing natural size of worm.

Fig. 2.—Side view of head showing œsophageal bulb (*a*) protruding beyond opening of mouth, and proboscis thrown back as when the animal feeds.

Fig. 3.—Ventral view of head showing aperture of mouth (*a*).

Fig. 4.—Enlarged view of stomach. *a* & *b*. Bands of sphincter muscles.

Fig. 5.—Enlarged dorsal view of part of body of worm, showing (*a*) attachment of hairs used in locomotion; (*b*) muscular bands partially contracted passing along each side of animal; (*c*) alimentary canal; (*d*) semi-opaque granules in protoplasm.

Fig. 6.—Vegetable tube inhabited by worm. *a*. Showing fold of integument that sometimes partially covers the back of the head of the worm.